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Effect of pre-treatments on storage stability of bottle gourd (*Lagenaria siceraria*) Petha: An intermediate moisture food

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Abstract
In intermediate moisture food, in order to reduce moisture content from fruits and vegetables, various pre-treatments are applied. The present work was carried out in an attempt to preserve highly nutritious and mineral rich bottle gourd in the form of sweet delicacy –Petha and studying the effect of pre-treatments like soaking in Lime water concentration [Ca $(OH)_2$] and Lime water soaking time (ST) on the storage stability at temp. 4-7℃ for 90 days. Three samples A, B and C were prepared in 75℃B sugar syrup with 1% $Ca(OH)_2$ solution having soaking time:120, 150, and 180 mins. Sample C with 180 mins (ST) was found to have lower moisture content (16.74±0.03%), high TSS (79±1℃B) and highest ash content (0.799±0.064%) while pH of Sample B was lowest (4.0±0.2) among the samples. There was significant difference ($p< 0.05$) in increase in SPC during storage period and Sample C was acceptable till 60th day. No significant difference was observed in yeast and mold count during storage period and also among the samples (A, B & C) suggesting no effect of ST on microbial growth. Sensory evaluation indicated insignificant effect of ST on sensory attributes of samples.

Keywords: Petha, Intermediate moisture food, Bottle gourd, Lime solution

1. Introduction
Intermediate moisture foods (IMF) are shelf stable foods with water activity (a_w) ranging from 0.85 to 0.65. IMF have water activity below the point where most of the bacteria cannot grow but they are susceptible to yeast and mould attacks. Murraba, candy, sugar confectionary, bakery, jams, jellies, etc. all come under Intermediate Moisture Food. Among them sugar soaked/smeared/dipped/coated, osmotic dehydrated fruits and vegetables constitute a large group generally called as murabba/candies? Yadav & Singh, 2014 [13], prepared an intermediate moisture banana with better flavor and good storability. Petha is also IMF and is prepared from fully ripened ash gourd fruits, osmotically dehydrated with lime water and immersed in sugar syrup. According to Singh *et al*., 2011 [11], petha is a sweet dish for patients suffering from hypertension. Although 99% of petha available in market is prepared from ash gourd, another fruit with similar nutraceutical properties comes from the same family of *Cucurbitaceae*, is bottle gourd *(Lagenaria siceraria).* It is grown widely and consumed largely as vegetable in India, Sri Lanka, South Africa, Indonesia and Malaysia (Ahmad & Ahmad, 2021) [1]. According to Barot *et al*., 2015 [5], and Parle & Satbir, 2011 [9], bottle gourd is one of the excellent fruits gifted to mankind by the nature having all the essential components required for a healthy and disease-free life. Parle & Satbir, 2011 [9], mentioned bottle gourd as a native vegetable of India and its wild races are still found in Dehradun and Malabar coastal region. They also reported bottle gourd as good source of ascorbic acid, beta-carotene, minerals, vitamin B complex, pectin and dietary fibre etc. It is characterized by light green colour which changes to pale as the fruit ripens. Its shape and size vary from long, round, oblong and club shaped extending from 4-40 inches in length. The nutritional composition of bottle gourd mentioned by Barot *et al*., 2015 [5], are moisture 94%, protein 1.2%, fat 0.2%, carbohydrate 3.7%, fibre 0.7% and ash 0.5%. With loads of medicinal and functional properties, an attempt was made to preserve it for longer time and process it into more acceptable form especially for lower age group people. Petha, being the sweet delicacy is very popular and osmotic dehydration technology helps to increase the storage life of fruits and vegetables is most opted for bottle gourd. Moreover, Ahmad & Ahmad, 2015, also investigated the shelf-life stability of the bottle gourd candy by optimizing the sugar syrup concentrations (°B) and treating the fruit with 2% Ca (OH) 2.

They selected round and oblong shaped bottle gourd for their studies. Singh *et al*., 2011, [11] studied the effect of lime water concentration, lime water treatment time and sugar concentration in optimizing the process of manufacturing Angoori petha from ash gourd while Taynath *et al*., 2020 [12], optimized the process of petha manufacturing from Chayote fruit with similar process variables like lime concentration, lime solution treatment time, slice thickness, blanching time and sugar concentration.

Since lime [Ca(OH)2] water concentration and lime water soaking time considered important step in petha making (Singh *et al*., 2011) [11], an effort was made to study the impact of lime concentration and lime water soaking time in making petha from bottle gourd and to study storage stability at refrigeration temperature of 4-7°C for 90 days. The present investigation was an alternative method of making bottle gourd petha (candy) and the effect of lime water on its storage and physico-chemical properties.

2. Materials and Methods

2.1 Materials

Bottle gourd was obtained from the local vendor in vegetable market, Jhansi. The fruit was selected carefully so that we could obtain a well matured bright coloured fruit. Sugar was purchased from grocery shop and lime powder, potash alum and tartaric acid were procured from chemist shop. The experiments were carried out in the Food processing laboratory of Institute of Food Technology, Bundelkhand University, Jhansi.

2.2 Methodology

2.2.1 Preparation of product

The fruit, after washing peeling and decoring to remove seeds was cut horizontally and rectangular cubes were made with cutters to have the uniform shape and size. The cubes were pricked by stainless steel fork.

Lime water was prepared from lime powder having 1% concentration. Lime treatment improves the texture of the product by providing calcium ions to combine with natural pectin in the fruit forming calcium pectate increasing firmness during osmotic dehydration. Lovera *et al*., 2014 [7], studied the calcium impregnation as pretreatment in processing of papaya in sugar syrup. The fruit cubes were soaked into lime water solution (1%) for 120min, 150min and 180min. After stipulated time, the cubes were removed from the lime water and washed thoroughly with lukewarm, free flowing water for 5 to 10 mins.

Blanching was done for 2-3 mins with pinch of potash alum to fix the bright green color and getting rid of the musty and vegetable flavour from bottle gourd cubes (Fig. 1).

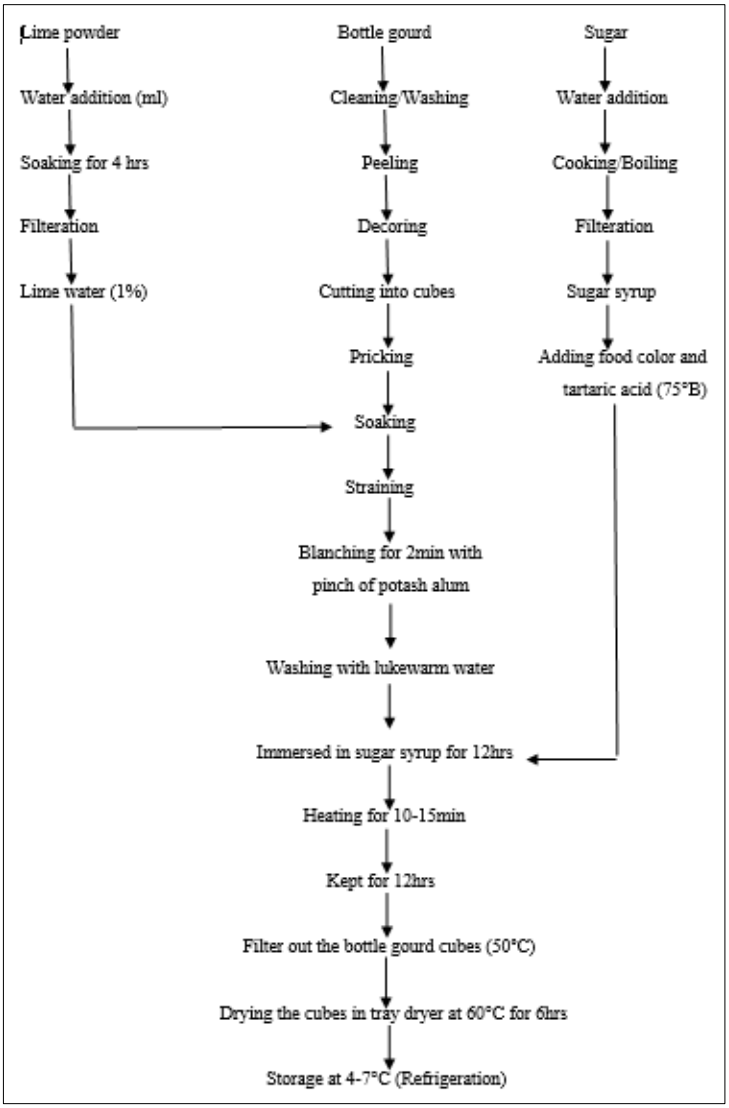

Fig 1: Process flow chart of bottle gourd petha

Sugar syrup of approximately 75°Brix was prepared (Ahmad & Ahmad, 2021) and bottle gourd cubes were immersed into it for 12 hours (Fig. 1). After 12 hrs. The cubes immersed in sugar syrup was again heated for 10 mins. And kept for another 12 hrs. The syrup was then drained and the cubes were tray dried at 50 °C for 4 hrs. To reduce moisture.

2.2.2 Optimization of Lime water soaking time (ST):
The effect of soaking time on storage and sensory quality of bottle gourd petha was studied by preparing following samples.
Sample A ⟶ 120 mins. Soaking Time (ST) in 1% Ca $(OH)_2$ solution with 75°Brix sugar syrup concentration.
Sample B ⟶ 150 mins. Soaking Time (ST) in 1% Ca $(OH)_2$ solution with 75°Brix sugar syrup concentration.
Sample C ⟶ 180 mins. Soaking Time (ST) in 1% Ca $(OH)_2$ solution with 75°Brix sugar syrup concentration.

2.2.3 Physico-chemical analysis
Moisture content and ash content was measured as per AOAC method (1975) [3]. pH was measured with pH meter (Model no. JSI-1004) using standard analytical method given by (Ranganna, 1997) [10]. Total soluble solids (T.S.S.) were measured by Erma Hand refractometer (ATC) at temperature 20 °C and values were expressed as °Brix.

2.2.4 Storage analysis
The storage stability and shelf-life were analysed through microbial and sensorial analysis. Samples were kept for 90 days in refrigeration with temperature 4-7°C. At regular intervals of 0^{th} day, 15^{th} day, 30^{th} day, 60^{th} day and 90^{th} day, microbial and sensorial test were conducted (Pandey *et al*., 2012) [8].

2.2.4.1 Sensory analysis
Sensory evaluation was carried out on 9-point hedonic scale at the prescribed intervals (Gautam, N, Siddiqui, 2020) [6] with 10 trained judges of sensory panel from Food technology field associated with Bundelkhand University.

2.2.4.2 Microbial analysis
Microbial tests were conducted for Standard Plate Count, Yeast/Mold and *E. coli* as per the methods mentioned by (Gautam, N, Siddiqui, 2020) [6] & (Aneja, 2018) [2].

2.2.5 Statistical analysis
To determine the significant impact of varied treatments upon samples on microbiological parameters (SPC and Y/M) Independent Samples Kruskal Wallis Test was carried out and the findings of sensory analysis were statistically analysed using Independent Samples Median Test. For all statistical tests software package IBM SPSS Statistics 20 was used.
The standard deviation (SD) and mean for all the data was calculated using MS Excel 2007.

3. Result and Discussion

3.1 Physico-chemical analysis
Moisture content (%) in Table. 1 indicated the decrease in Sample C (16.74±0.03) as compared to Sample A (18.63±0.05) and Sample B (18.86±0.02), due to the increased penetration of sugar syrup resulting in high T.S.S. (°Brix) and drop in moisture content. Pre-treatment like lime water soaking and blanching increased the osmotic dehydration (Yadav & Singh, 2014) [13]. Ahmad & Ahmad, 2021[1], also reported similar trend in moisture and ash during storage period of bottle gourd candy. Ash content (%) was also reported to be high in Sample C (0.799±0.064) in comparison to Sample A and Sample B indicated the longer soaking time (180 mins) in lime water (1%) causing deeper penetration of $Ca(OH)_2$ solution. pH in Sample B was found lower than the pH of Sample A (4.0±0.2) and Sample C (4.2±0.1). The drop in pH was correlated to the organic acids formed during the immersion period due to fermentation of the sugar by microbes (Bacteria and Y/M) present (Pandey *et al*., 2012) [8] and was not desirable. The initial sugar syrup was 75°Brix, the variation of T.S.S. in all three samples, i.e., Sample A, Sample B and Sample C, were observed in final product was due to the T.S.S. contributed by fruit *(Lagenaria siceraria)* and sugar syrup both. The highest T.S.S. in Sample C indicated the enhanced osmotic dehydration due to longer (180 mins.) lime water soaking time (ST). Yadav & Singh, 2014 [13], reported the alkali treatment to be more effective than acids in removing water from fruits and vegetables. Taynath *et al*., 2020 [12], too reported the preliminary treatments had significant effect on physico-chemical properties of finished product. He also stated that moisture is the primary determinant in storage stability of product. Higher is the moisture lower will be the shelf-life and vice-versa.

Table 1: Physical analysis of LP (0^{th} day)

Product	Moisture (%)	Ash (%)	pH	TSS
Sample A	18.86 ± 0.02	0.671± 0.023	4.2± 0.1	76± 2
Sample B	18.63 ± 0.05	0.714± 0.66	4.0± 0.2	77± 1
Sample C	16.74 ± 0.03	0.799± 0.064	4.2± 0.1	79± 1

*All above values are mean ± SD of three findings.

3.2 Storage analysis
The shelf stability in fresh and stored (refrigerated at 4-7 ºC) bottle gourd petha was studied on the basis of microbial and sensorial changes. All three samples A, B and C, were monitored on the scheduled days, i.e., 0^{th} day, 15^{th} day, 30^{th} day, 60^{th} day and 90^{th} day respectively for microbial population and sensory evaluation.

3.2.1 Microbial analysis
In Table 2, it was evident that SPC increased linearly in all the three samples (A, B and C) till 30^{th} day and there was significant difference ($p< 0.05$) found along the storage days. Similar trend of increased bacterial counts with significant difference were obtained by Pandey *et al*. 2012 [8] during storage study of petha at refrigerated temperature. Sample C reported 2.944 log cfu/ml on 60^{th} day at temperature 4-7 °C while in Sample A and B, the microbial colonies were too numerous to count (TNTC) hence excluded from the study. Lactic acid bacteria like bacillus and lactobacillus due to their thermoduric nature thrives in medium rich in fermentable sugars along with yeast and moulds making samples prone to

spoilage. There was insignificant difference (p>0.05) observed in Yeast/ Moulds counts during the storage period suggested that low temp (4-7 ºC) retarded the growth of microbes without preventing them to multiply so the refrigerated petha were prone to bacterial, yeast and mould spoilage (Pandey *et al*., 2012) [8]. No significant difference (p>0.05) was observed in SPC as well as Y/M colonies across the samples (between Sample A, B and C) suggesting limited effect of lime water soaking time (ST) on the microbial growth.

E. coli count was reported NIL in all samples throughout the storage period.

The above results were found in accordance with FSSAI permissible limit for microbial growth in fruit candies.

Table 2: Microbial analysis at of stored LP at temperature 4-7 °C (refrigeration)

Day	Sample A			Sample B			Sample C		
	SPC	Y/M	E. coli	SPC	Y/M	E. coli	SPC	Y/M	E. coli
0th	2.602	2.071	NIL	2.568	2.00	NIL	2.492	2.492	NIL
15th	2.792	2.320	NIL	2.763	2.271	NIL	2.785	1.934	NIL
30th	2.968	2.526	NIL	2.913	2.294	NIL	2.892	2.049	NIL
60th	TNTC	TNTC	NIL	XXX	XXX	NIL	2.944	2.621	XXX
90th	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

* All values are mean ± SD of triplicates

3.2.2 Sensory analysis

The effect of lime water soaking time (ST) on sensory attributes of bottle gourd petha was analysed (Table 3) indicating insignificant effect of lime water soaking time (120min, 150min and 180min) on sensorial attributes within the samples (A, B & C). On the contrary, Taynath *et al.*, 2020 [12], reported the limited effect of lime water soaking time (ST) on sensory attributes like firmness, hardness and texture of product which cannot be neglected. The OAA was found highest on 0th day in sample C among all the samples (A & B). The same trend was observed on 15th day and 30th day with sample C scoring highest value. Statistically, with ANOVA test there was no significant difference seen among the samples in entire storage period of product but sample C (ST 180 min.) seemed to sustain the microbial and sensory stability till 60th day suggested the combined effect of pre-treatments like lime water concentration, lime water soaking time and blanching on increased osmotic dehydration causing high TSS (ºB) leading to low moisture and increased microbial stability. Further, a significant difference ($p< 0.05$) was evident in texture and overall acceptability (O.A.A.) attributes in samples (Fig 2, 3 and 4) across the days (0th day to 30thday) showed a decrease in the overall acceptability (8.6±0.3 to 7.82± 0.5) and texture attributes (8.9±0.5 to 7.89±0.4) of Sample A, B and C, during the storage period from 0th day to 30th day at temperature 4-7°C (Table 3) due to increased microbial population causing softening of tissues in bottle gourd petha by hydrolysis of carbohydrates producing alcohols, acids, ketones etc affecting organoleptic properties (Pandey *et al*., 2012) [8].

Colour, appearance and flavour attributes in Table 3 remained unchanged (p>0.05) throughout the storage period was supported by Taynath *et al*., 2020 [12]. He stated that lime water concentration and lime water soaking time (ST) had significant effect on colour and appearance of Chayote petha. Asiah & Handayani, 2018 [4], also reported the increase in colour, flavour and crispiness of pineapple fried product by soaking it in lime water solution.

Table 3: Sensory evaluation of LP

Days	Product	Colour	Flavour	Appearance	Texture	OAA
0th day	Sample A	7.8 ± 0.4	8.8± 0.3	8.5± 0.6	8.8± 0.5	8.47± 0.5
	Sample B	7.9 ± 0.3	8.5± 0.5	8.6± 0.4	8.8± 0.6	8.45± 0.4
	Sample C	8.0 ± 0.2	8.8± 0.4	8.7± 0.3	8.9± 0.5	8.6± 0.3
15th day	Sample A	7.60 ± 0.4	8.21 ± 0.3	8.50 ± 0.5	8.03 ± 0.1	8.08 ± 0.3
	Sample B	7.81 ± 0.2	8.72 ± 0.6	8.15 ± 0.3	8.34 ± 0.5	8.25 ± 0.4
	Sample C	7.82 ± 0.4	9.01 ± 0.5	8.55 ± 0.6	8.47 ± 0.3	8.46 ± 0.4
30th day	Sample A	7.28 ± 0.5	8.10 ± 0.3	8.03 ± 0.6	7.89 ± 0.4	7.82 ± 0.4
	Sample B	7.40 ± 0.7	7.96 ± 0.6	8.0 ± 0.4	7.92 ± 0.3	7.82 ± 0.5
	Sample C	7.39 ± 0.4	8.32 ± 0.5	8.14 ± 0.3	8.02 ± 0.2	7.96 ± 0.3
60th day	Sample A	XXX	XXX	XXX	XXX	XXX
	Sample B	XXX	XXX	XXX	XXX	XXX
	Sample C	7.3 ± 0.5	8.5 ± 0.7	8.0 ± 0.6	8.12 ± 0.4	7.98 ± 0.5
90th day	Sample A	XXX	XXX	XXX	XXX	XXX
	Sample B	XXX	XXX	XXX	XXX	XXX
	Sample C	XXX	XXX	XXX	XXX	XXX

*All values are mean±SD log cfu/ml of three determinants.

4. Conclusion

Intermediate Moisture Food, very old technique of preserving fruits and vegetables through osmotic dehydration offers a great scope for developing countries with minimum infrastructure to process perishable foods like fruits and vegetables. Bottle gourd originated in India is one of the miraculous vegetables having loads of nutritional and therapeutic properties was tried to preserve in a most acceptable - sweet i.e., petha. The effect of pre-treatments like lime water concentration and soaking time was studied on the storage and sensory quality of bottle gourd suggested the combined effect of pre-treatments increases the osmotic

dehydration in fruits and vegetables making them shelf-life stable product readily acceptable. The present study suggested the storage life of bottle gourd petha with 75°B sugar syrup can be expected to be 30 days after treating with 1% Ca $(OH)_2$ for 180 min and 2-3 min blanching.

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